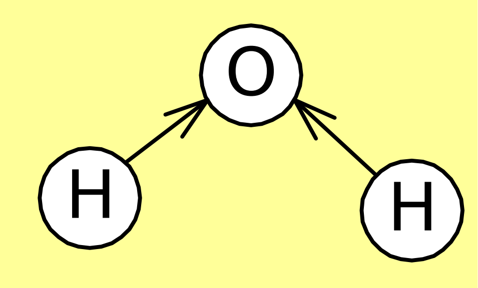
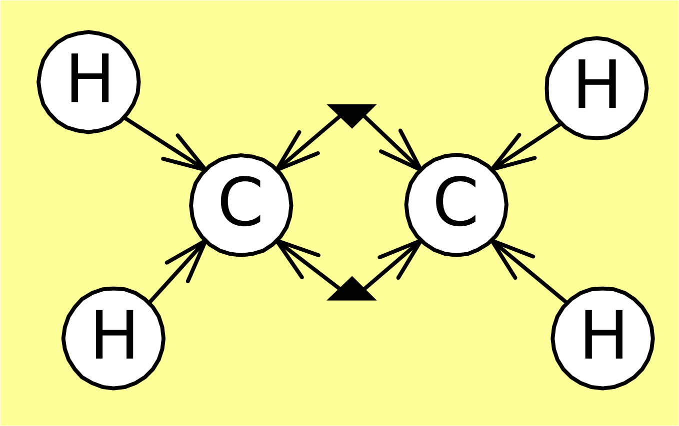
Substitution

Sub-Atomic Particles

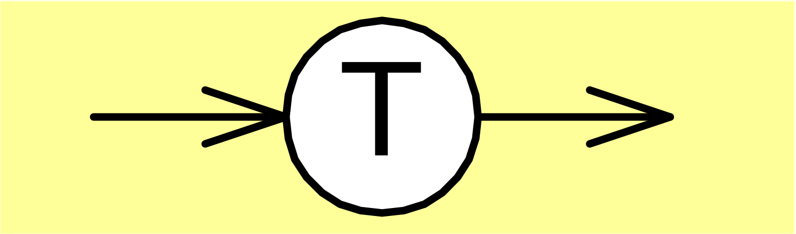
Molecules





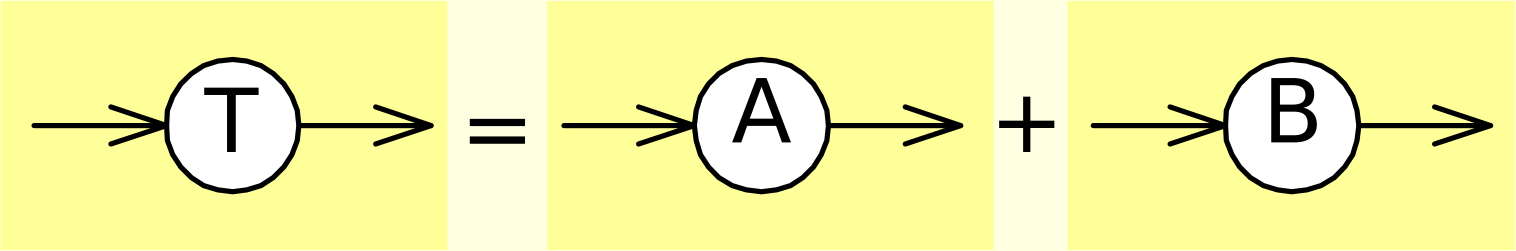
SubAtomic Physics

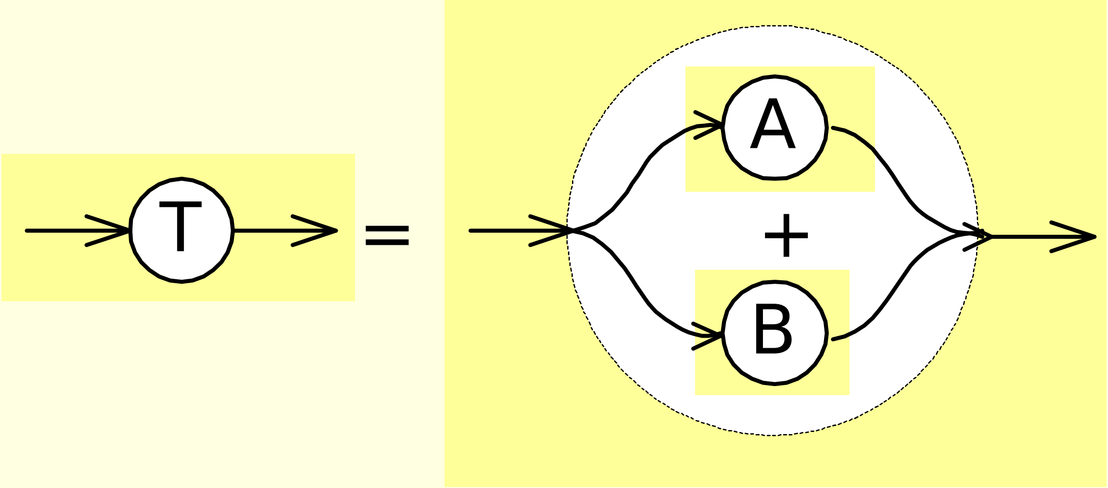
What's Inside?



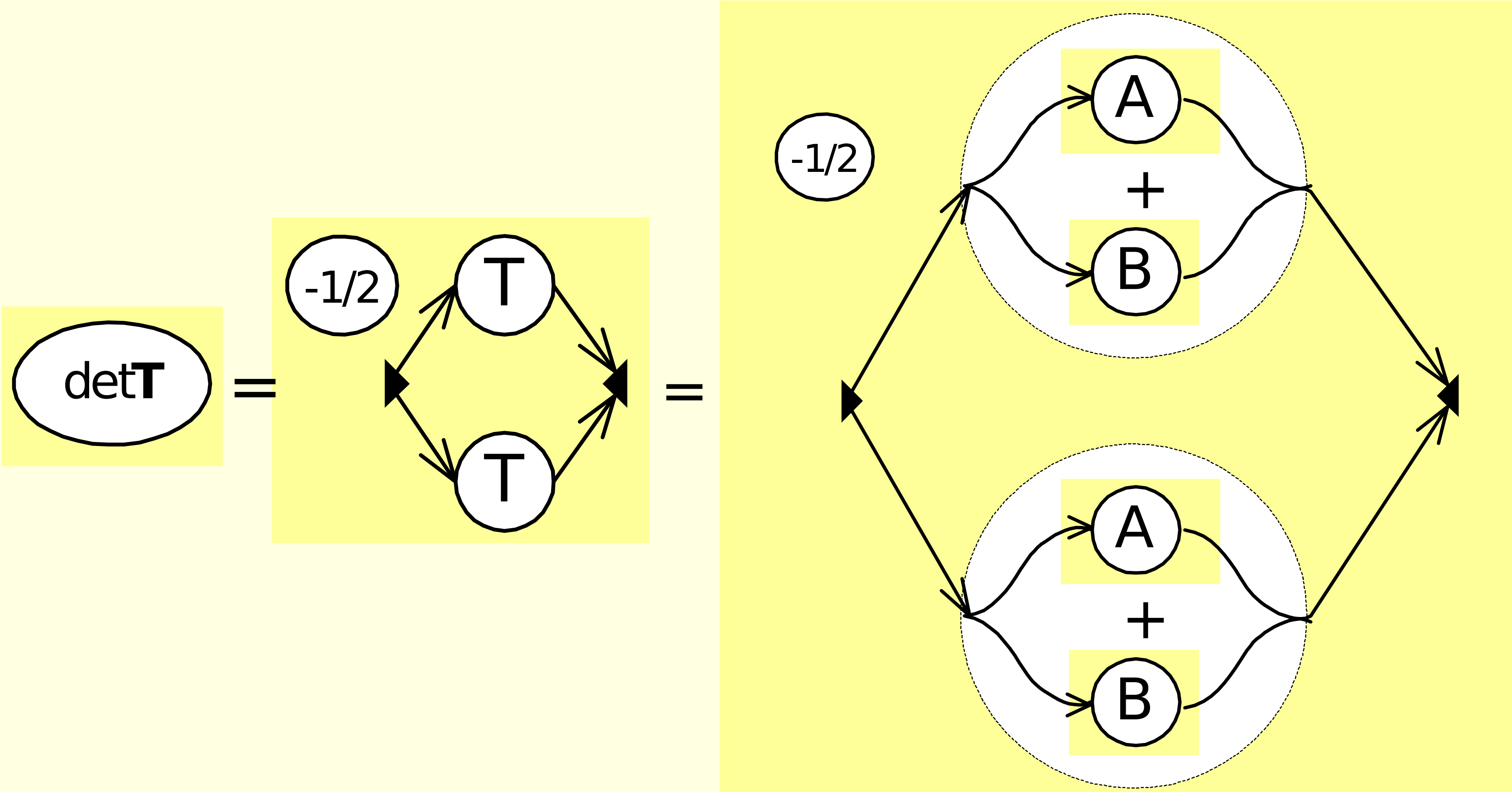
Sum of Matrices

$$\mathbf{T} = \mathbf{A} + \mathbf{B}$$

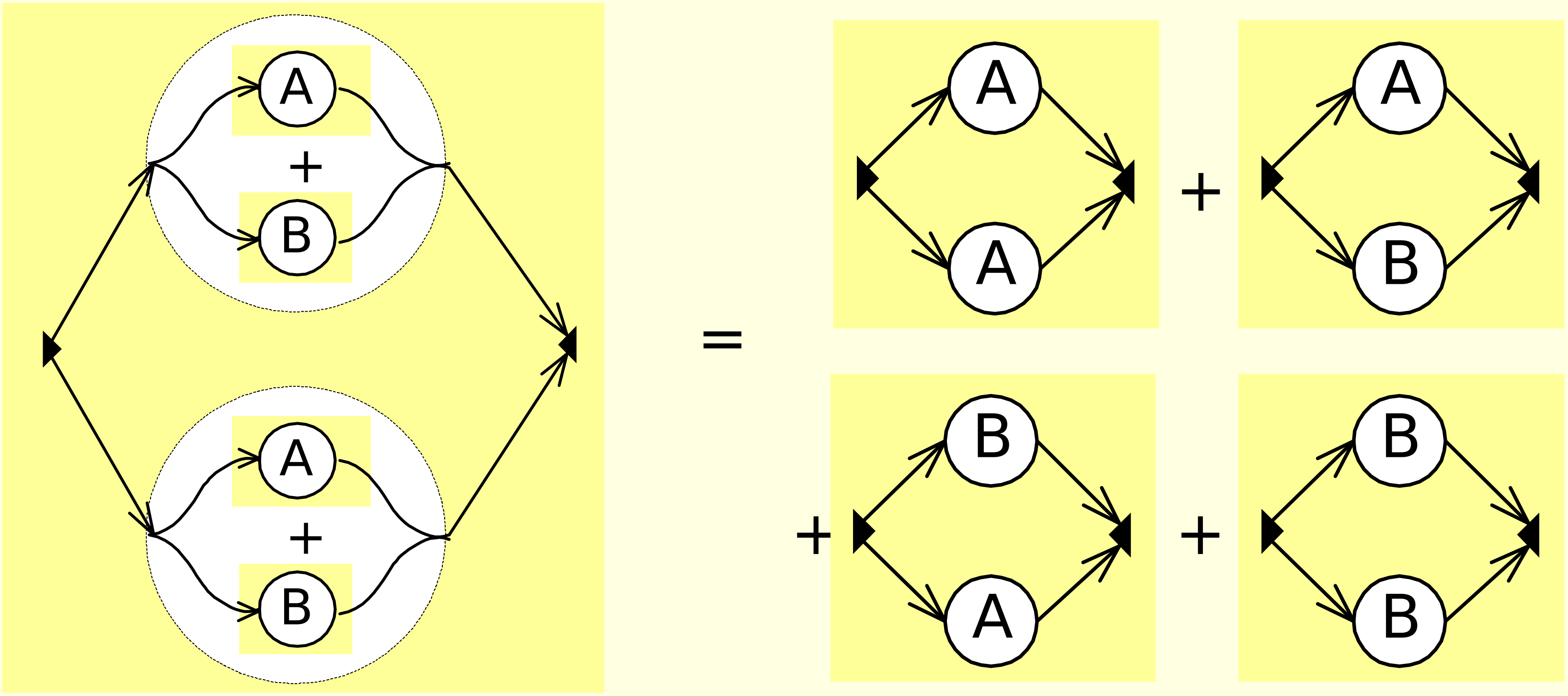




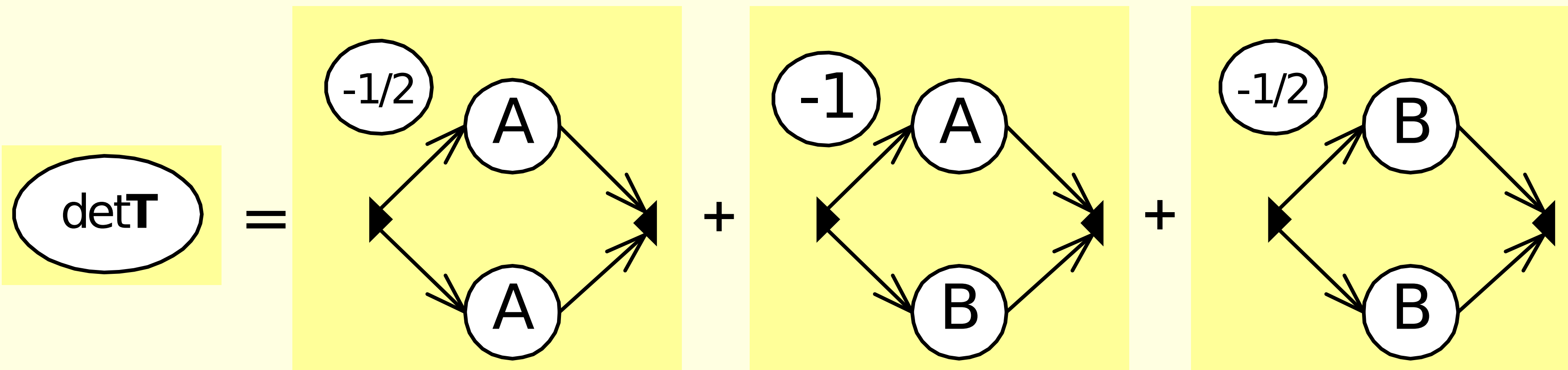
Determinant of T



Determinant of T



Determinant of T



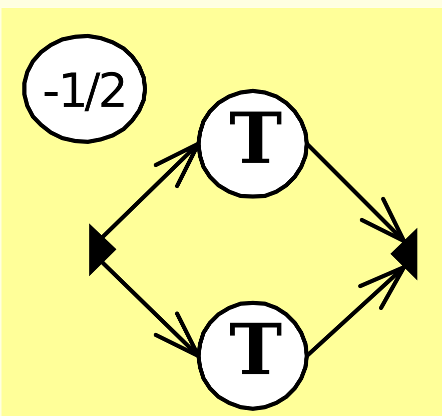
$$\det\left(\mathbf{A}+\mathbf{B}\right) = \det\mathbf{A} + fcn\left(\mathbf{A},\mathbf{B}\right) + \det\mathbf{B}$$

Eigenvectors/Eigenvalues

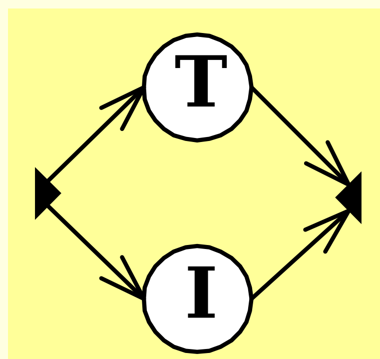
$$\mathbf{TL} = / \, \mathbf{L}$$

Characteristic Equation 2D(1DH)

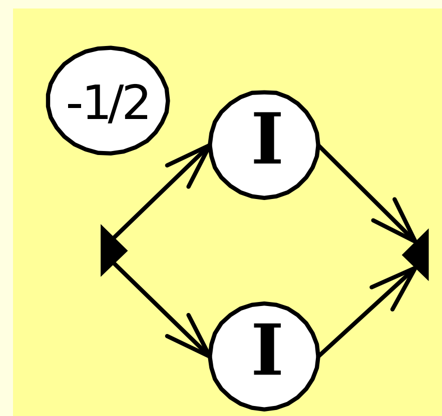
$$\det\left(\mathbf{T} - \lambda \mathbf{I}\right) = 0$$



$+ \lambda$

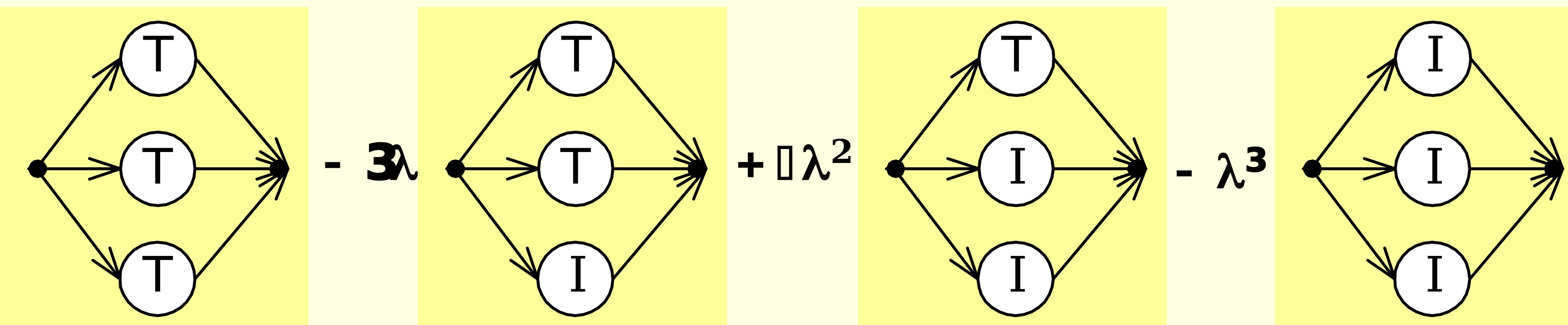


$+ \lambda^2$



Characteristic Equation 3D(2DH)

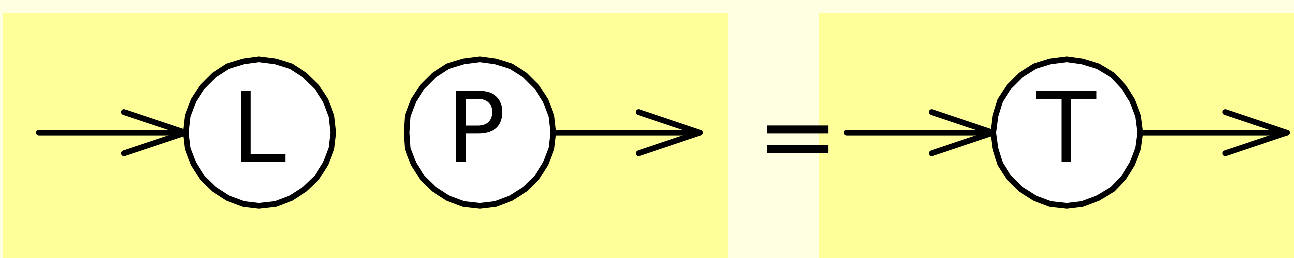
$$\det\left(\mathbf{T} - / \,\mathbf{I}\right) = 0$$



Outer Product

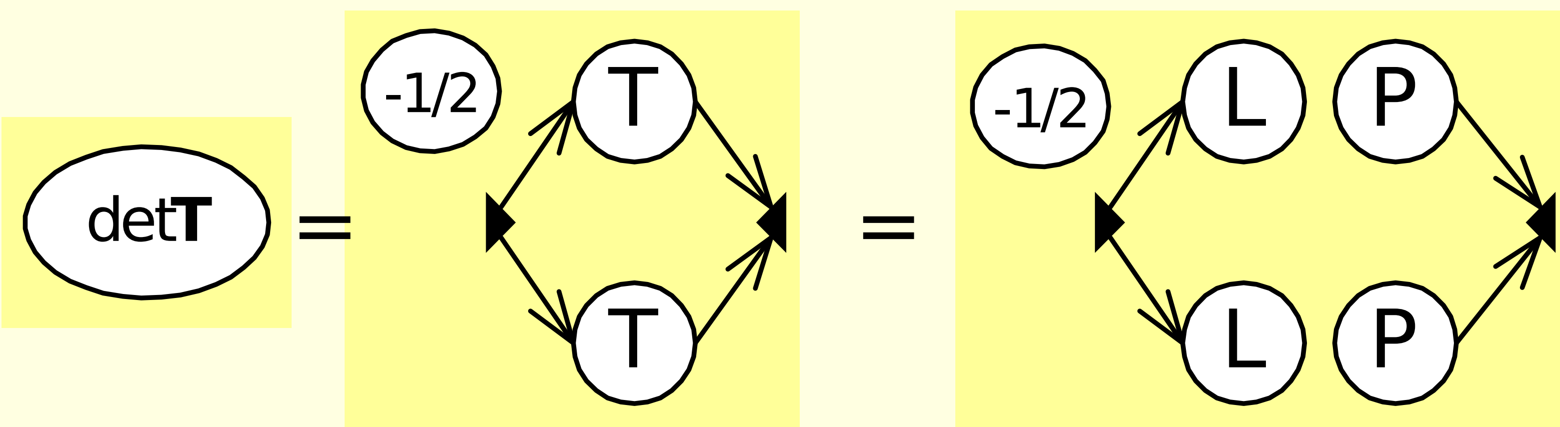
$$\begin{bmatrix} a \\ b \end{bmatrix} \begin{bmatrix} x & w \end{bmatrix} = \begin{bmatrix} ax & aw \\ bx & bw \end{bmatrix}$$

$$\mathbf{L}\,\mathbf{P} = \mathbf{T}$$



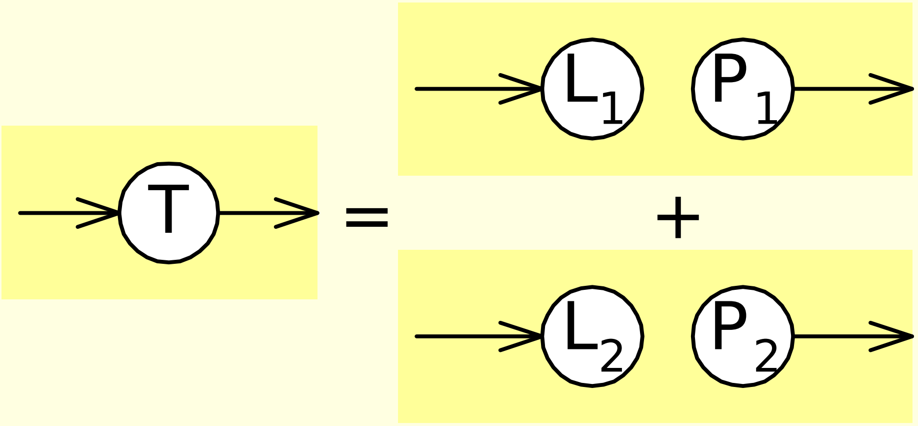
Outer Product is Singular

$$\det\begin{bmatrix} ax & aw \\ bx & bw \end{bmatrix} = axbw - bxaw = 0$$

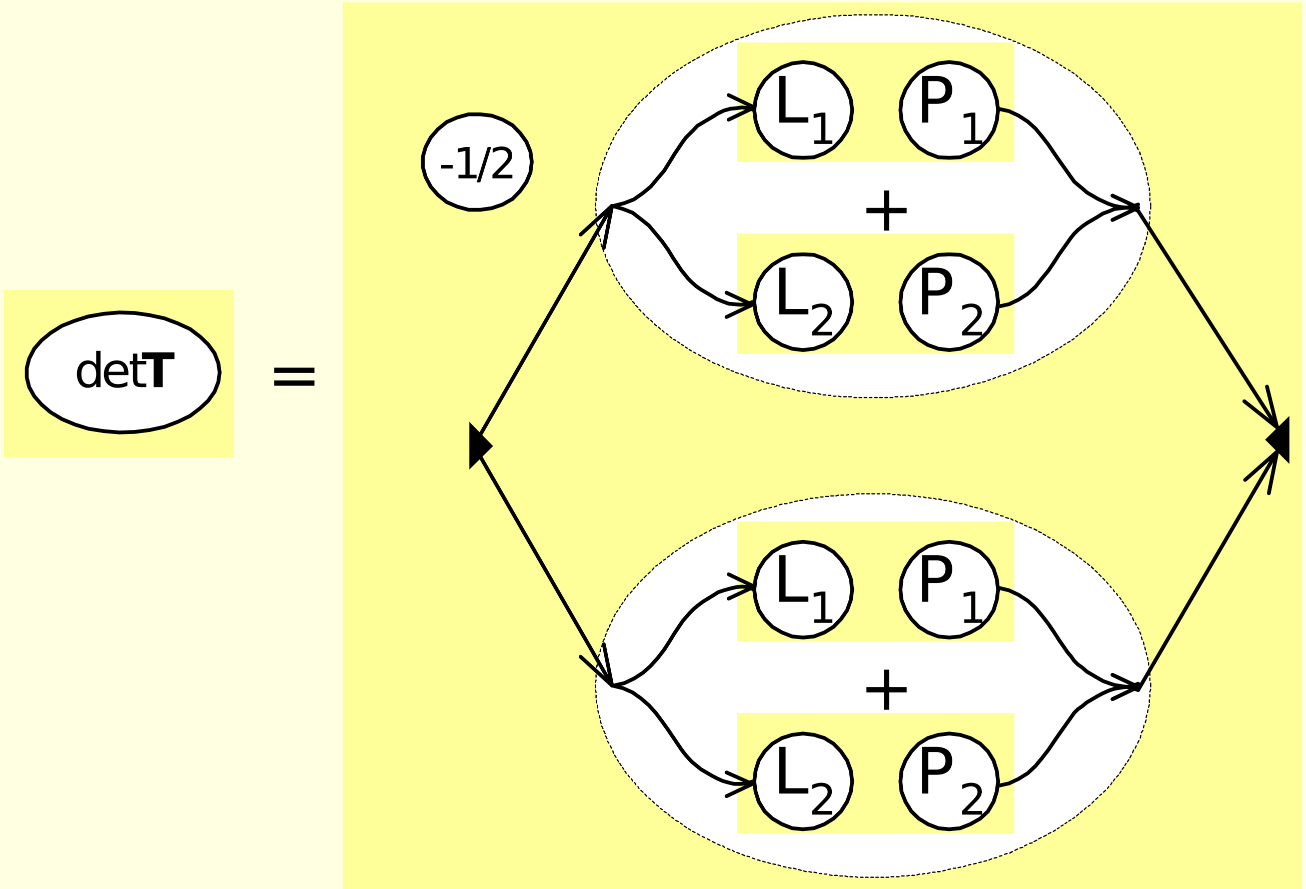


Sum of Outer Products

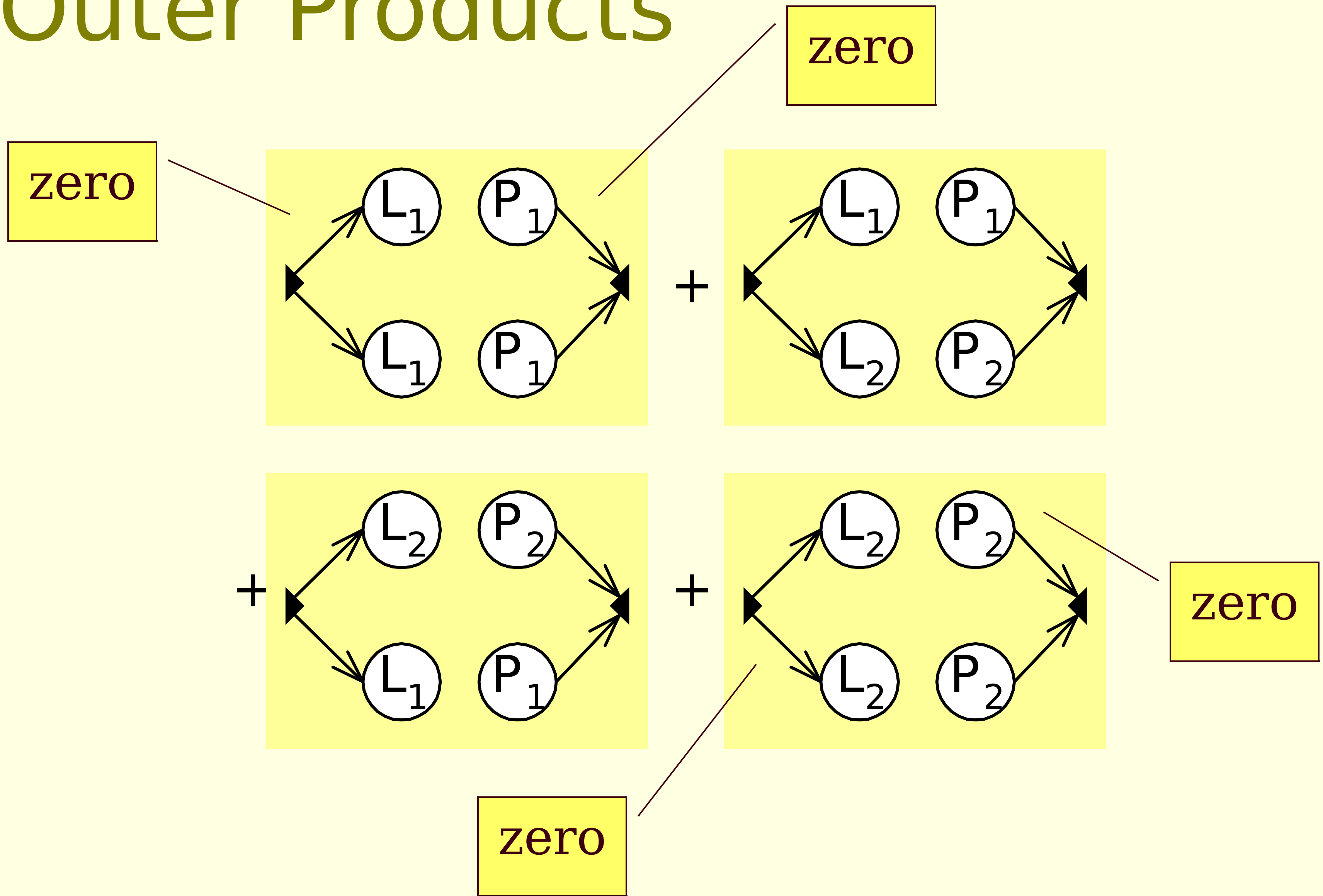
$$\mathbf{T} = \mathbf{L}_1\mathbf{P}_1 + \mathbf{L}_2\mathbf{P}_2$$



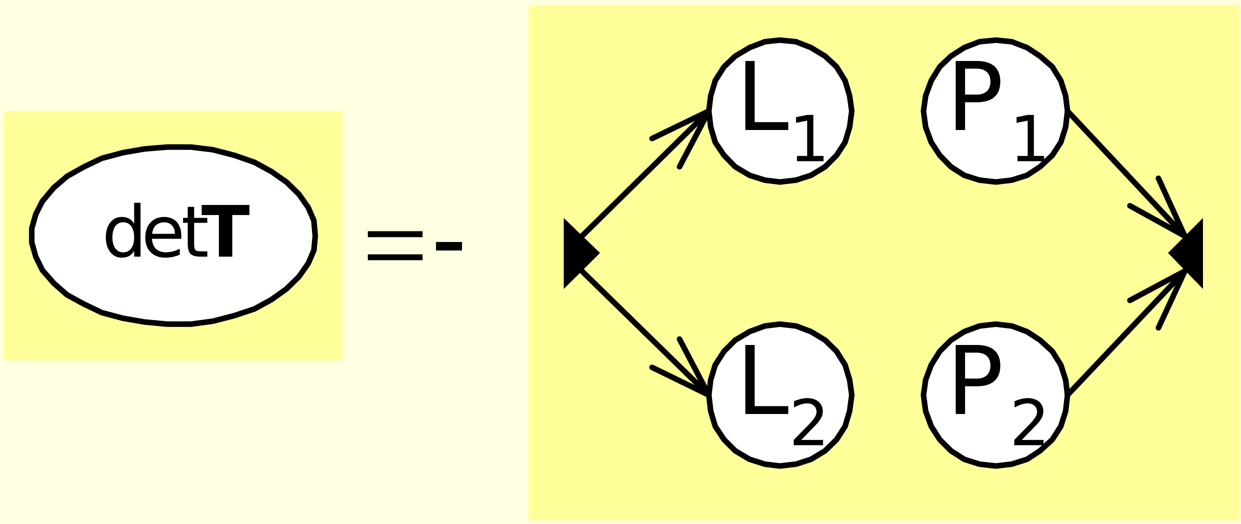
Determinant of Sum of Outer Products



Determinant of Sum of Outer Products

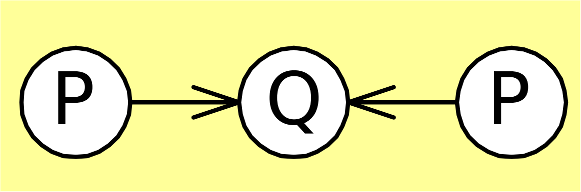


Determinant of Sum of Outer Products



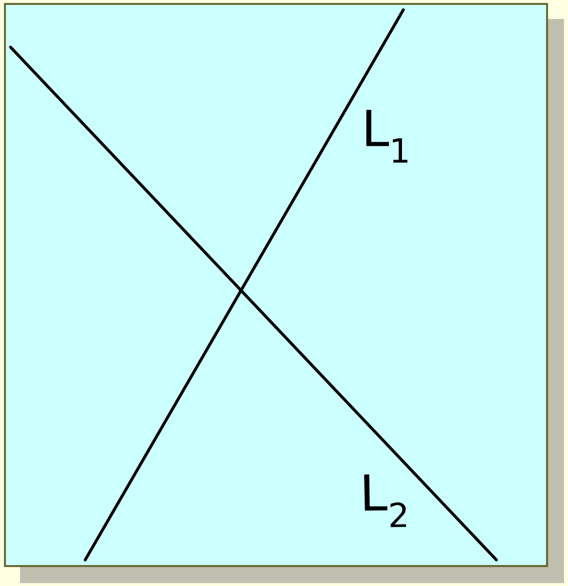
Symmetric Tensors

$$\begin{bmatrix} x & y & w \end{bmatrix} \begin{bmatrix} A & B & D \\ B & C & E \\ D & E & F \end{bmatrix} \begin{bmatrix} x \\ y \\ w \end{bmatrix} = \mathbf{PQP}^T = 0$$



$= 0$

Factorable Quadratic Tensor



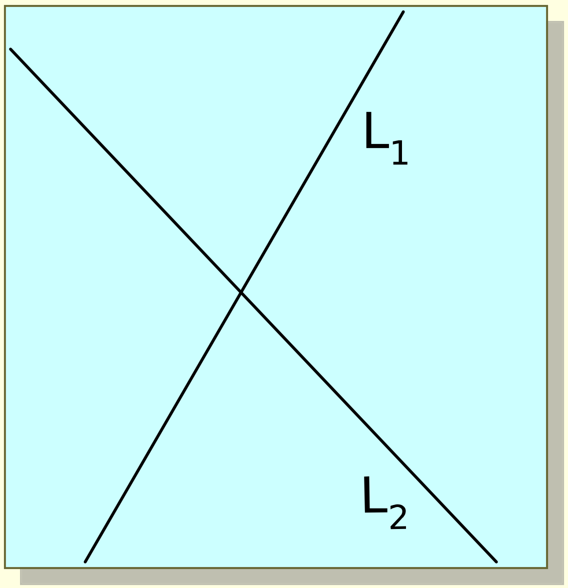
$$\left(\mathbf{P}\mathbf{L}_1\right)\left(\mathbf{P}\mathbf{L}_2\right) = 0$$

$$= \begin{bmatrix} x & y & w \end{bmatrix} \begin{bmatrix} a \\ b \\ c \end{bmatrix} \begin{bmatrix} p & q & r \end{bmatrix} \begin{bmatrix} x \\ y \\ w \end{bmatrix}$$

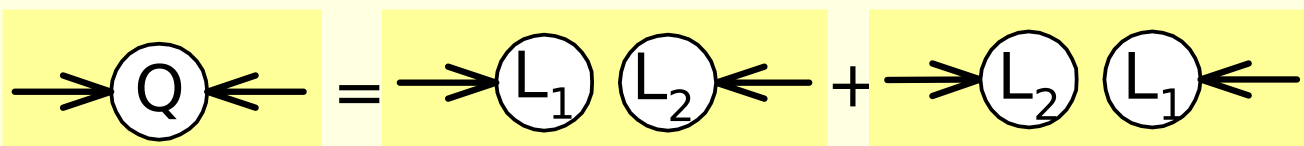
$$= \mathbf{P}\left(\mathbf{L}_1 \mathbf{L}_2^{T}\right)\mathbf{P}^{T}$$

$$\mathbf{Q} \stackrel{?}{=} \mathbf{L}_1 \mathbf{L}_2^{T} = \begin{bmatrix} a \\ b \\ c \end{bmatrix} \begin{bmatrix} p & q & r \end{bmatrix} = \begin{bmatrix} ap & aq & ar \\ bp & bq & br \\ cp & cq & cr \end{bmatrix}$$

Factorable Quadratic Tensor

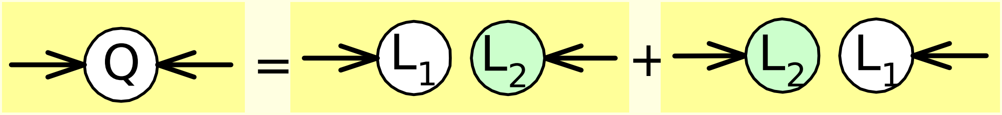


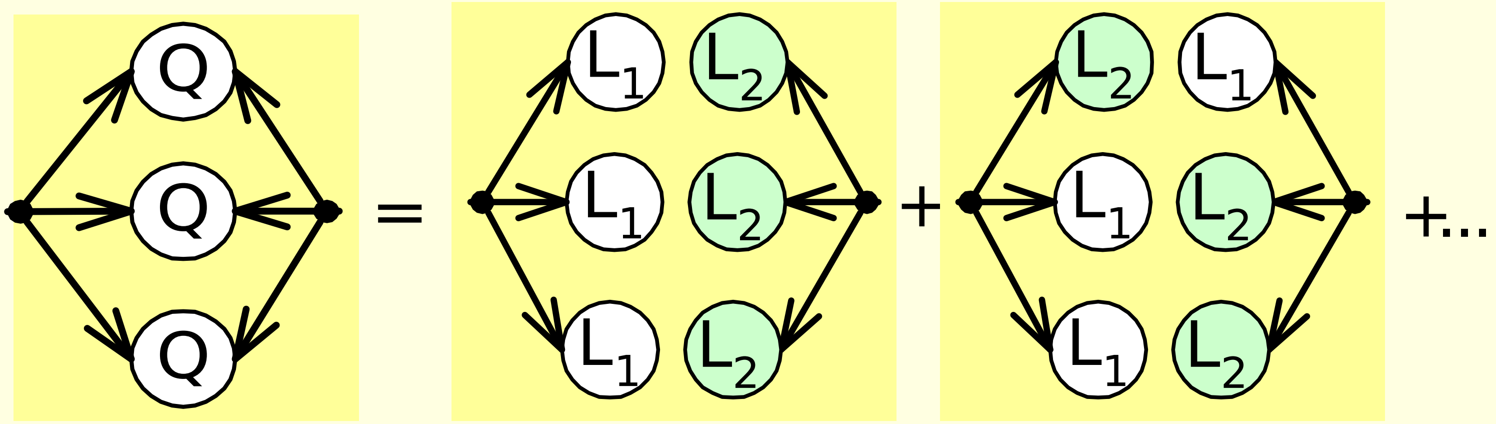
$$\mathbf{Q} = \mathbf{L}_1\mathbf{L}_2^{T} + \mathbf{L}_2\mathbf{L}_1^{T}$$



$$\mathbf{PQP}^{T} = \mathbf{PL}_1\mathbf{L}_2^{T}\mathbf{P}^{T} + \mathbf{PL}_2\mathbf{L}_1^{T}\mathbf{P}^{T} = 2\left(\mathbf{PL}_1\right)\left(\mathbf{PL}_2\right)$$

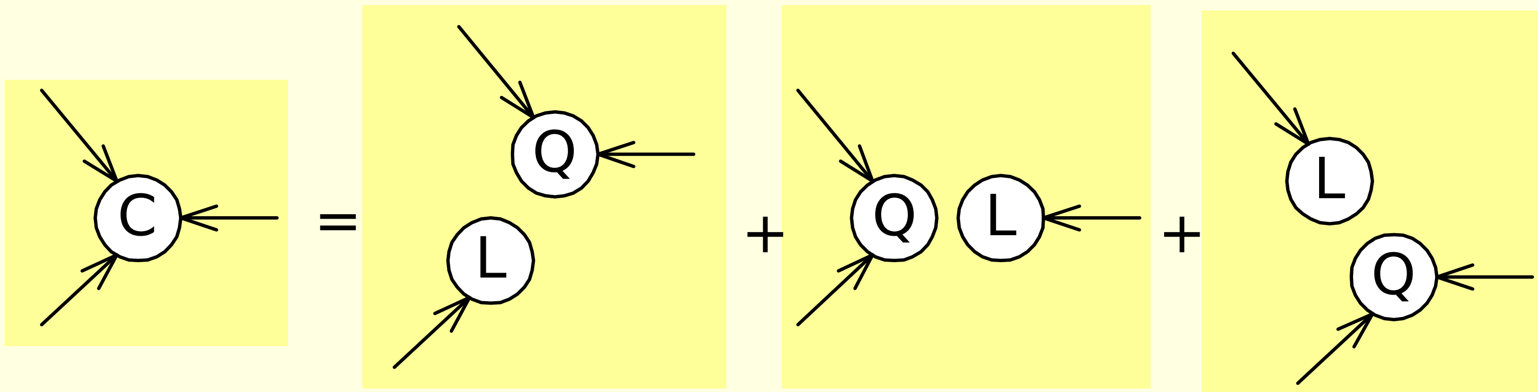
Determinant of Factorable Quadratic



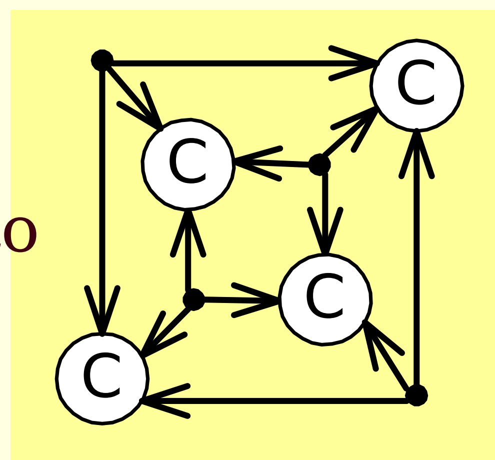


$= 0$

Factorable Cubic Tensor



Substitute Into



After The Break

- Polynomial Roots and Discriminants
- Polynomial Resultants and Generalizations
- Quadratic and Curves and Theorem of Pascal
- Properties of Cubic Curves